(19) Patent Office of Japan (JP)(11) Publication of Patent Application

JAPANESE PATENT APPLICATION (KOKAI)(A) Showa 63-306824

(43) Publication: Showa 63 (1988) 12/14

Int. CL. 5 ID Code Office Cont'l No.
B 23 H 3/00 8308-3C

Verification request: Not requested

Number of claims of the invention: 1

Number of pages (total of 5 pages)

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(21) Filed Number: Application Showa 62-138777

(22) Filed Date: Showa 62 (1987) 6/2

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JP 63-306824

[Note: Names, addresses, company names and brand names are translated in the most common manner. Japanese language does not have singular or plural words unless otherwise specified by a numeral prefix or a general form of plurality suffix.]

(54) [Name of the Invention]

Finishing Machining Method by Using Electro-Chemical Processing

Description of the Invention

1. Name of the Invention

Finishing Machining Method by Using Electro-Chemical Processing

2. Scope of the Claims

Finishing machining method by using electro-chemical processing, which is a finishing machining method where in a static electrolyte solution the processed item and the electrode(s) are positioned facing each other and pulses are applied in the space between this material that is being processed and the electrode and together with that as the material synthesized through the electrolysis in the space between the above described processed material and the electrode is being intermittently removed the finishing processing is conducted; where on the unprocessed surface of the above described material to be processed prior to its processing, in advance, a sheet shaped insulating material is adhered and then the finishing processing is conducted.

3. Detailed Explanation of the Invention

[Technical Field of the Invention]

The present invention is an invention about a finishing processing method that is a finishing processing method conducted through an electro-chemical processing method, and especially, it is a finishing processing method that is conducted by electrolytic processing where there is no generation of drooping etc., at the interface between the processed surface and the unprocessed surface of the processed material that is formed from a three-dimensional type shape, and where the surface gloss of the interface surface is processed within a short amount of time and also at a high precision.

[Previous Technology]

As the metal processing method according to the previous technology the following methods are known: the electrolysis processing method where in the gap between the material to be processed that is supplied to the processing and the electrode(s), sodium nitrate or sodium chloride etc., electrolyte solution is flooded, and as this electrolyte solution is flowing at a high rate together with that an electrolysis synthesized material, which hinders the stabilized electrolytic action, namely the separated from the solution metal compounds or metal ions and hydrogen gas, etc., a direct flow of electric current flows from the material that is being processed to the electrode and the processing is conducted (described in the inventions reported in the Japanese Patent Application Laid Open Number Showa 61-71921 and Japanese patent Application Laid Open Number Showa 60-44228); the electric discharge processing method where the material that is being processed and the electrode are placed mutually facing each other inside a lamp oil type, etc., process liquid, and also, these are connected to the appropriate electric source, and in the above described gap an instantaneously generated spark electric discharge or transition arc electric discharge are generated and through the above electric discharge energy the material subject to the processing is processed (as described according to the reported in the Japanese Patent Application Laid Open Number Showa 60-26646 and the Japanese Patent Application Laid Open Number Showa 60-177819).

[Problems Solved by the Present Invention]

However, in the case of the above described electrolytic processing methods, especially, in the case of the processing of the bottom parts of three dimensionally shaped objects (said to be the processing of items with three-dimensional structure that have indented cave like parts), it is difficult to conduct the precision copying of the electrode onto the processed item, and because of that there is the unfavorable condition that it is said that it is not possible to obtain high precision surface possessing parts; and also, in the case of the latter electric discharge processing method it is difficult to obtain a good surface precision and because of that there is the unfavorable condition that, for example, for the mirror finishing, etc., surface finishing, it is said that a large amount of time and labor are required.

Then, the authors of the present invention have invented and disclosed a processing finishing method using electrolytic processing that eliminates these unfavorable conditions, as described according to the Japanese Patent Application Number Showa 62-27616, however, in the case of this finishing processing method the processed item and the electrode are mutually facing each other at a predetermined distance and this material to be processed and the electrode are immersed in static electrolytic solution and the processed item is processed.

However, in the item subject to the processing, for example, there is an installation base surface, where processing is not conducted and that is a non-processed surface and there is a processed surface, which requires a mirror surface type glossy surface to be obtained, however, according to the above described processing method, the whole body of the item subject to the processing is immersed within the static electrolytic solution and the processing is conducted and because of that at the interface part between the non-

processed surface and the processed surface, the processing progresses through to the non-processed surface and because of that there is the unfavorable condition that at the interface part, the so-called "sagging (drooping)" is generated.

Also, as it is disclosed according to the reported in the Japanese Patent Application Laid Open Number Showa 56-95535, the electrostatic processing method is also known where the non-processed surface of the material to be processed is wetted and impregnated with a dielectric electrolytic solution that is admixed within the electrolytic solution, which flows through it, and an electric insulating layer is formed on the surface of the non-process surface and the processing is conducted. However, in the case when this method is used for the processing finishing operation there is the unfavorable condition that is said that the dielectric solution that is admixed into the electrolytic solution significantly decreases the quality of the surface of the finished surface of the product, and it is a method that cannot be used at all in the electrolytic method inside static electrolytic solution.

[Goal of the Present Invention]

Here the present invention is an invention that has as a goal to eliminate the above described unfavorable conditions, and especially, it has as a goal to realize a finishing processing method that is conducted by electrolytic processing where there is no generation of drooping etc., at the interface between the processed surface and the unprocessed surface of the processed material that has a three-dimensional type shape, and where the surface gloss of the interface surface is processed within a short amount of time and also at a high precision.

[Measures in Order to Solve the Problem Points]

In order to achieve the above described goal the present invention is characterized by the fact that the processed item and the electrode are positioned facing each other and pulses are applied in the space between this material that is being processed and the electrode and together with that as the material synthesized through the electrolysis in the space between the above described processed material and the electrode is being intermittently removed the finishing processing is conducted; where on the unprocessed surface of the above described material to be processed prior to its processing, in advance, a sheet shaped insulating material is adhered and then the finishing processing is conducted.

[Effect]

According to this structure of the present invention, on the non-processed surface of the material subject to the processing, where processing is not conducted, in advance, a processing is conducted whereby an adhesive insulating tape etc., sheet shaped insulating type material is adhered and fixed and because of that through this insulating material the non-processed surface does not undergo electrolytic processing and at the interface between the non-processed surface and the processed surface there no generation of "sagging" etc. Also, because of the fact that it is a process that is inside a static liquid,

there is also no generation of separation of the insulation material during the finishing processing and after the completion of the processing it can be easily separated from the non-processed surface by peeling off.

[Practical Examples]

Here below the diagrams are used as reference and the practical examples of this present invention are described in further details and explained.

Figures 1 ~ 3 show one practical implementation example of the present invention. According to the figures, 1 represents the processing equipment that is used for the practical realization of the finishing processing method according to the present invention, and this processing equipment 1 is formed from the following: the fixing device 3, which fixes the material to be finished and processed 2, the electrode fixing device 5, which fixes the electrode 4, the motion change part 7, which changes the back and forth movement of the rotational movement of the electrode moving part 6, the pulsating electric current generating electric source device 8, the controller device 12, which is comprised of the motor drive control part 9, and the processing condition control part 10 and the electrolytic solution flow control part 11, the inputting device 13, which inputs the data etc., related to the material to be processed 2, the electrolytic solution filtration device 14, and the processing tank 15, etc.

The above described device 3 used for fixing the material to be processed is a high insulating properties possessing table or a table made from ceramics material, and for example, the material to be processed 2, which is to be processed through an electric discharge process is fixed by using the bolt 16, etc. Also, regarding the above described electrode fixing device 5, on the bottom edge of the rod 17 that is provided on its lower part, for example, an electrode 4, which is formed from a pure copper and is used at the time of the above described electric discharge processing, is fixed so that its electrode surface 4a and the processing surface 2a of the above described item to be processed 2, are held in the gap 18, so that they are in the same orientation direction in the three-dimensional space. Then, regarding the above described electrode fixing device 5, through the above described electrode drive part 6 and the movement change part 7, it is moved up and down within the above described gap 18 at a predetermined value that must be set. Namely, from the signal that is generated through the electrode drive part 6's rotary encoder 20 and tach generator 21, through the control signal that exits from the motor movement control part 9 of the above described controller device 12, the rotation of the motor 19 is controlled, and this rotational movement of the motor 19 is translated into back and forth motion through the motion change part 7, and the above described electrode fixing device 5 is moved up and down, and the it is fixed to the predetermined gap 18 between the electrode surface 4a and the processing surface 2a.

Regarding the electric source device 8, which supplies pulsating electric current with an electric current density (average electric current per unit surface area) of 70 A/cm2 or less to the gap between the above described material to be processed 2 and the electrode 4, it is a device that through the control signal from the process conditions controlling part 10,

generates a pulsating electric current with the predetermined electric current density calculated according to the surface area of the material to be processed 2, and because of that it contains the following: the direct electric current source part 22, the electric charge/discharge part 23, which is comprised of multiple electric condensers, electric discharge and electric discharge switches, the electric charge/discharge controller device 24, which is comprised of electric voltage and electric current comparator and a gate circuit, etc.

Also, regarding the processing conditions controlling part 10 of the above described controller device 12, it contains the electric charge/electric voltage setting electric charge part, which sets the electric voltage setting of the above described electric condenser devices, the pulse generating part, which generates pulses with a predetermined time interval and width, the electric current wave form setting part, which sets the electric current wave shape of the electric charge that is electrically discharges, the calculating – treatment part, which calculates and treats the processing conditions (CPU), etc.

The above described inputting device 13 is a device that inputs the material and the surface area of the item to be processed, the class, the finish surface roughness and the initial electrode gap etc., which correspond to the dimensional precision of the desired finishing processing, and each of these signals are output to the motor motion change part 9 and the process conditions control part 10 of the controller device 12.

The above described electrolytic solution filtration device 14 is a device where the electrolytic solution 28, which contains the generated by the processing electrolysis synthesized material is filtered, and because of that based on the control signal from the control part 11, which controls the flow of the electrolytic solution, the electrolytic solution 28 is supplied to the processing tank 15 at a constant (certain) solution pressure, and together with that the electrolysis synthesized material, etc. that is generated in the gap between the process surface 2a and the electrode surface 4a during the processing is removed and because of that the electromagnetic valve 29, etc., is controlled so that at each 1 pulse or at each several pulses new and fresh electrolytic solution 28 is sprayed into the gap between the processed material 2 and the electrode 4 at the same time as the rising movement of the electrode 4.

After that an explanation will be provided of the finishing processing method using this equipment.

First, on the non-process surface 2b that is not to be processed of the process material 2, which has been processed into the predetermined shape by, for example, a electric discharge processing, an adhesive insulating tape etc., sheet shaped insulating material 25 is adhered. Then, this process material 2 is fixed into the process material fixing device 3 and together with that on the lower edge of the rod 17 of the electrode fixing device 5 the above described electrode 4, which is used at the time of electric discharge, is fixed, and this electrode 4 is lowered and its electrode surface 4a is facing and contacts the process surface 2a of the process material 2, and together with that it is immersed into the electrolytic solution 28. This position is denoted as the start (original) point A, and the

electrode 4 is raised to the position where the initial electrode gap is maintained, and the electrolytic solution 28 is flooded into the gap between the process surface 2a and the electrode surface 4a, and as the electrolytic solution 28 becomes static (it is the state where it is said that the movement or flow of the electrolytic solution stops), this is made to be the starting point of the processing and the process starts.

In the finishing processing period, through the control signals from the processing conditions controlling part 10, from the electric source device 8, for example, a pulsating electric current where the pulse on time period is 10 milli seconds or less is supplied to the gap between the process material 2 and the electrode 4. By that, the material of the process surface 2a is dissolved and separated. The predetermined pulsating electric current is supplied once or several times and after that through the signal from the motor movement control part 9 the electrode 4 is moved and it is raised and the electrode surface 4a is distanced from the process surface 2a. Through this separation gap the electrolysis synthesized material in the gap between the process surface 2a and the electrode surface 4a is removed together with the electrolytic solution 28 through the action of the electro-magnetic valve 29 etc., of the electrolytic solution filtration device 14.

After the electrolysis synthesized material has been removed, the electrode 4 is lowered downward and the electrode surface 4a comes in contact with the process surface 2a. By that, the above described start point A position and the current position are compared by the control device 12 and the processing depth per one process (1 process per each 1 pulse or per each several pulses) is measured. After that, the electrode 4 is raised again so that the predetermined gap 18 between the above described process surface 2a and the electrode surface 4a is maintained and electrolysis solution 28, which does not contain electrolysis synthesized material from the process layer 15, is flooded in the gap between the process surface 2a and the electrode surface 4a and together with that 1 ~ 5 seconds after stopping the electrolytic solution 28 the pulsating electric current is supplied and after that the following process is conducted. Moreover, in order to compensate for the electrolytic solution 28 that is removed together with the electrolysis synthesized material that has been synthesized by one through several electrolysis process steps on the process layer 15, new clean electrolytic solution 28 is supplied from the clean tank of the electrolytic solution filtration device 14.

This way in the gap between the process surface 2a and the electrode surface 4a that are mutually facing each other so that the predetermined gap distance 18 is provided is flooded with the electrolytic solution 28 and in the state where the electrolytic solution 28 has stopped electric current with predetermined pulsations of 10 msec or less is supplied in the gap between the process material 2 and the electrode 4, and the process surface 2a material is dissolved and separated into the electrolytic solution 28 and after that the electrolysis generated material that has been generated in the space between the process surface 2a and the electrode surface 4a is removed and again the electrode surface 4a is made to come in contact with the process surface 2a and by that the process depth per one process step is measured and a continuous technological process is repeated a

predetermined number of times through the signal of the controller device 12 as this value is made to be a multiplier of the total accumulation.

The above described process depth accumulated value is compared to the measured value of the processed depth that has been calculated by the process conditions control part 10 based on the input data that has been input through the input device 13, and at the time when the process depth cumulative value compared to the processed depth measured value becomes within the predetermined variance (for example, 1 micron), through the control signal of the above described process condition controlling part 10, the electric density of the pulses of the electric source device 8 is changed to an electric density exceeding 3/2 of the electric density of the initial period of the finishing processing and it is switched to a long pulse electric current where, for example the pulse on time period is within the range of 15 ~ 60 milli seconds. Then, by using this electric density pulsating electric current through the same method as described here above a predetermined number of process steps are conducted and after the completion of the process the insulating material 25 is peeled off and separated from the non-process surface 2b and the whole finishing processing is completed.

This way it is a finishing processing method that is according to the electrolysis processing according to the present invention and it is a finishing processing where prior to the beginning of the finishing processing, in advance, an insulating material 25 is adhered on the non-process surface 2b and because of that the non-process surface 2b is not processed , and there is no generation of "sagging" etc., at the interface part between the process surface 2a and the non-process surface 2b, and also, it is a processing conducted in a static liquid and because of that there is also no separation of the insulating material 25 during the process, and it is possible to obtain non-process surface 2b and process surface 2a that are good surface quality installation base surfaces. Also, if in the process equipment 1, the processed to the predetermined type shape process material 2 and the electrode 4 are installed, and the finishing conditions etc., are input through the input device 13 and it is activated, a mirror type glossy surface can be obtained within a short amount of time without human intervention, and on its surface there is no the accumulation of internal stresses and metal structure is also not changed, and also there are no changes of the material at all that are due to the mechanical flaws generation, and also there is no deterioration of the thermal treatment prior to the processing, etc., and it is possible to obtain results that show improved product quality and are better mechanically than according to the current metal die processing even in the finishing processing field where the labor reduction has been slow.

Moreover, in the case of the present invention, it is not limited to the metal die processing field, and it can also be applied and used in finishing processing of silicon single crystals or gallium arsenide substrates in the industrial production of semiconductor materials, and in the mirror surface processing of aluminum discs for the magnetic recording devices using mono crystalline diamond, etc., fields where a small internal stress on the surface caused by mechanical processing becomes a problem. Also, naturally it can be used as finishing processing in the large scale of high void jar, etc., after the thermal treatment, etc.

[Results From the Present Invention]

As it has been explained in details here above, in the case of the finishing processing method through electrolytic processing according to the present invention, it is a finishing processing method where inside a static electrolyte solution the process material and the electrode are provided so that they are mutually facing each other and in the space between this process material and the electrode pulses are supplied and at together with that while the electrolysis synthesized material that is synthesized in the above described space between the process material and the electrode is intermittently being removed the finishing processing is conducted, where on the non-process surface of the above described process material where processing is not conducted, in advance, a sheet shaped insulating material is adhered and then the finishing processing method is conducted; and because of that the non process surface of the process material is not processed and the generation of the "sagging" at the interface between the non process surface and the process surface can be prevented, and also, it is a finishing processing that is conducted as the electrolyte solution is in a static state and because of that there is no separation of the insulating material during the processing and due to that it is possible to obtain a non process surface and a process surface with good surface quality. Also, an insulation material is adhered onto the non process surface and after the processing it is separated and peeled off and because of that fact it is also an easy operation and it is possible to obtain high precision and also fine surface roughness mirror surface type gloss possessing three-dimensional metal surfaces within a short time period.

4. Brief Explanation of the Figures

Figure 1 is a front view diagram showing the finishing processing equipment that practically realizes the present invention, Figure 2 is a side view diagram of the same equipment, Figure 3 is a schematic structural diagram of the same equipment.

1.....processing equipment, 2.....process material,
2a.....process surface, 2b.....non process surface,
4.....electrode, 8.....electric source device,
12.....controller device, 15.....processing tank,
25.....insulating material.

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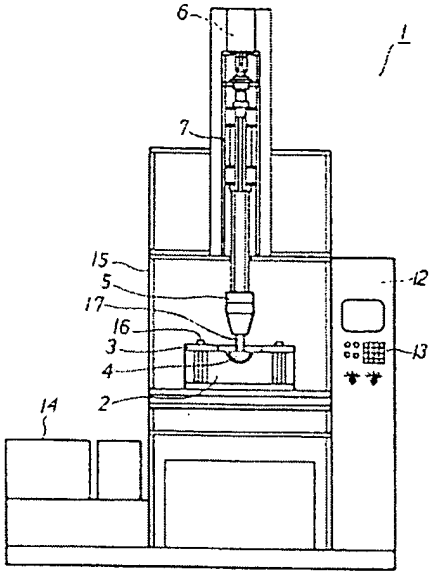
10/17/05

第 1 図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12
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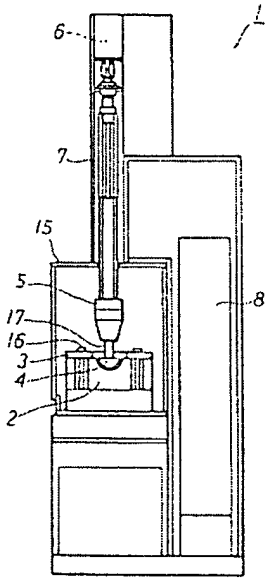
第 2 図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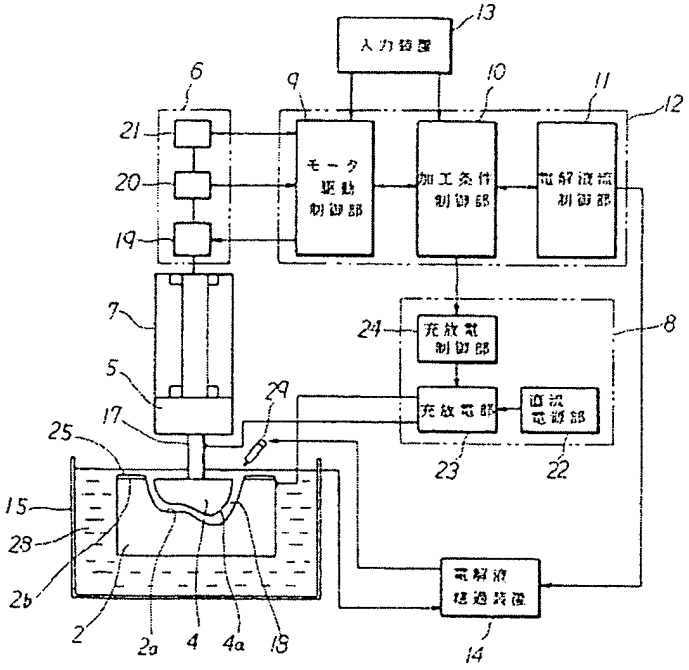
第 3 図


13
入力装置
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モータ駆動制御部
加工条件制御部
電解液流制御部
7
24
充放電制御部
8
5
29
充放電部
通流制御部
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23
22
15
28
26
2
2a
4
4a
18
電解液供給装置
14